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STUDIES IN NEARCTIC DESERT SAND DUNE ORTHOPTERA PART II. TWO NEW GRASSHOPPERS OF THE GENUS *TRIMEROTROPIS* FROM THE UTAH DESERTS

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This, the second part of the author's new series of studies on Nearctic Sand Dune Orthopterans, reports on a large, arenicolous grasshopper inhabiting the sand dune areas of the San Rafael Desert of southeastern Utah and a very distinctive but smaller race dwelling on the sand dunes of western Utah in the Great Salt Lake Desert, both deserts being eremological components of the Great Basin Desert.

In 1932, just before my departure for Lingnan University, Canton, China, Miss Grace Olive Wiley, who lost her life in late July of 1948 from the bite of an Indian cobra, presented to me two females and a male of a very large *Trimerotropis* that she had collected in Emery County, Utah, on July 21, 1921. For many years these three specimens have reposed in my collection awaiting the time when I might have the chance to study this handsome race in the field and obtain additional materials for the type series. That opportunity came in 1958, in the second summer of my three-year summer grant with the National Science Foundation, while exploring and studying the dune biota of the Great Basin Desert.

On Sunday evening, August 3, 1958, as the sun was setting, I found a small drift sand area just north of where Utah Highway No. 24 crosses the San Rafael River, some 33 miles north of Hanksville and 5 miles west and 22 miles south of Green River. A few minutes later while scouting around, I flushed a very large reddish grasshopper with bright yellow wings heavily banded with black. I finally captured the wary creature after much stalking and chase. On examination, I realized immediately that at last I had found the habitation of Miss Wiley's specimens.

By dark, I had collected a small series of this new race. The most interesting feature that I discovered in the chase was that the female made a loud cracking whir when alighting and that the male produced only a faint whir at the most. In most Oedipodine acridids producing sounds in wing flight, it is the male that makes the loud

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rippling or crackling sounds while the females produce only a slight sound or are mute.

In this new race both females and males could fly silently when pursued. When flying unpursued or undisturbed, the female when alighting produced the loud crackling sound, announcing her arrival to any male or males in the immediate vicinity. The purpose of her performance certainly produced the desired effect, for as she was alighting with loud rippling song, the male or males in the area flew up and towards her on shortflight to quickly settle or if nearer her hopped quickly in her direction. When, however, they were 12 to 18 inches away from her, they slowed down their walking speed and approached with more caution. Life for such females appeared to be a very lively one with so many suitors responding to her call.

The females and males were very wary and I pursued one quite some time back and forth across the highway. Many of the escape flights were quite long, up to fifty yards or more. All the females observed produced the most sound when settling down, the male practically none or at most a faintly audible whirl.

After dark, Jimmy Brister, the high school lad with me, and I collected some hours by Coleman lantern, then journeyed southward in search of the Cane Spring Dunes. About midnight, in the light of the car, large drift dunes showed up on the very edge of the road where the pavement ended. Here we camped some 19 miles north of Hanksville, Utah. I collected until 2 a.m. and found three of the hoppers by lantern light, perched for the night in dune vegetation.

Next morning, the dunes were very hot and the hoppers wily. By dint of considerable effort and much perspiration I obtained a nice series here of the handsome race. My field notes recorded their habits during the hot morning similar to those of the late evening before. When a female alighted with loud clatter any males nearby flew a short distance towards her, then stopped to walk rapidly in her direction, then stopped again and approached more cautiously the last short interval of several inches. Apparently the sight of her big yellow wings with heavy black bands and loud rippling wings was enough to charm all males of her kind within considerable distance of her.

It is an honor to name, I regret posthumously, this very large and attractive dune grasshopper after its discoverer, Miss Grace Olive Wiley, who as a young woman before beginning her amazing and dangerous career as a noted herpetologist, started out her professional life as an entomologist.

Trimerotropis agrestis gracewileyae, n. subsp.

The sand dune grasshoppers of the *agrestis-citrina* complex inhabiting southeastern Utah and eastern New Mexico (Mescalero Sands) so closely approximate each other in their morphological features that their separation into species groups is most difficultly accomplished. Although I had considered this new race as a variety of *agrestis* for many years, the discovery, in 1959, of another *Trimer-*

tropis on the Mescalero Sands which was similar in size, coloration and taxonomic features, cast some doubt as to its specific origin. Finally, after much study, I discovered that the only clue of value to their group origin lay in the coloration of the inner face of the caudal femora. In the *agrestis* group this face is a uniform coral red, in the *citrina* group the coloration shade is a slightly deeper red, not enough to differentiate in itself, but there was in addition, two black patches on the inner face of the caudal femora which were diacritical. Of these, the proximal one is the largest and almost centrally placed while the smaller distal patch is located about the apical three-quarters.

Having resolved the species-group complex in this most difficult Acridoid genus, further characterization of the new and magnificent variety, becomes much simplified.

Compared with typical *agrestis* from the type region of Nebraska, *gracewileyae* is one and one-half times larger in size. Whereas, typical *agrestis* has the lateral lobes of the pronotum of the same breadth throughout, even though the lower margin is at an oblique angle, the new Utah race has the lateral lobes actually broadest just above the enlarged posterior angle of the lateral lobes of the pronotum. In the new race, the depression of the fastigium and frontal costa is more prominently enhanced by the raising of the carinae edging the fastigium, the foveolae of the vertex and the frontal costa. The male of *gracewileyae* is considerably larger than the females of *agrestis* from Nebraska and the antennae appear exceptionally long.

The new race of *agrestis* is the largest *Trimerotropis* known, with the possible exception of *T. magnifica* Rehn, and cannot be confused with *agrestis* east of the Continental Divide. When once separated by the characters presented above, as well as others, from a new race of *citrina* soon to be described from the Mescalero Sands, *gracewileyae* cannot be confused with any other species of the genus *Trimerotropis* by reason of: its very large size, uniform reddish body coloration, isabelline and non-fasciated tegmina, and by the unspotted coral red coloration of the inner face of the caudal femora which, in many species of *Trimerotropis*, bears bands on that inner face similar to the fasciation observed on the outer face of the caudal femora.

Description: Male: Head with fastigium distinctly sunken between the well defined lateral carinae which commence, caudally, on the occiput where the inner margins of the compound eyes are narrowest apart, the carinae diverging slightly to the posterior portions of the lateral foveolae of the vertex, thence converging in straight lines to a position immediately above the median ocellus. From here they expand again around the median ocellus to continue diverging, moderately, to the clypeal margin. Frontal costa quite deeply sulcate throughout. Antennae very long slender, extending to the basal quarter of the caudal femora. Foveolae of the vertex well defined by carinae on their anterior margins, open behind.

Pronotum with the median carina low but distinct throughout, the prozona notched by two sulci forming two rounded lobes (when viewed in profile), the anterior lobe twice the length of the posterior

one. A trace of a lateral carina is discernible on the anterior lobe of the prozona and there is a well-defined low lateral carina on the anterior two-fifths of the metazona. The posterior margin of the dorsum of the pronotum is right-angular, the angle moderately rounded. Lateral lobes of the pronotum deep, the posterior margin diverging slightly ventrally so that the greatest breadth of the lateral lobes is just above the enlarged posterior angle. The inferior margin, due to the enlargement of the posterior angle, is quite obliquely angled. The posterior angle bears a large downward projecting tooth which has caused the lower margin to be oblique and the posterior margin to be broadest just above the posterior angle. Tegmina long and narrow, the apices extending for five-sixths the length of the caudal femora beyond the apices of the caudal femora.

Coloration: generally pale mottled reddish brown; the tegmina pale dull reddish in ground color with the veins of the cells straw-colored and the anal area (the ridge area in the closed tegmina) streaked with straw coloration. The tegmina bear isolated, small brownish blotches, but these do not coalesce sufficiently anywhere to indicate any type of fasciation. Caudal femora with lower face straw-colored, inner face entirely coral red without any trace of blackish areas. Caudal tibiae coral red on the inner face, pale whitish pink on the basal half exteriorly with coral red in the apical exterior half.

Wing 31.0 mm. across, wing disc pale yellow (11 mm. broad) with a broad black band 10 mm. wide which is almost as broad as the disc. Band curves through the center of the wing; apical portions beyond the band, hyaline with the veins in its central portion black, elsewhere pale yellow. The cubitus vein is yellow throughout, thus separating its anterior portion into a small costal area.

Holotype Male: Cane Springs Dunes, 19 miles north of Hanksville, Emery County, Utah, August 4, 1958, Ernest R. Tinkham. Measurements in millimeters with Glogau calipers: total length to apices of tegmina 40.9; body length 30.0; length to apices of caudal femora 27.8, pronotum 6.1 x 5.0; lateral lobes of pronotum measured from metazonal lateral carina to apex of tooth at the posterior angle 5.5 x 4.1 maximum breadth just above this tooth; caudal femur 16.7 mm. Holotype deposited in the Tinkham Eremological Collection.

Description: Female: Female closely similar to the male in all morphological features with the variations as noted here: pronotum with the lateral carinae on the fore portions of the prozona and the metazona slightly more prominent than in the male, otherwise the characters appear identical other than the usual heavier build characteristic of all females.

Wing similar to the male, total length 37.0 mm., the black band 11.5 mm. broad, the disc 13.5 mm. General tone of the disc a shade paler yellow than in the male. Spur, as in the male, very short and blunt, less than $\frac{1}{3}$ the breadth of the disc.

Ovipositor typical of the genus *Trimerotropis*.

Allotype Female: same locality as the Holotype. Caliper meas-

urements as follows: total length 49.5; body length 38.5; length to apex of caudal femur 35.5; pronotum 8.6 x 6.1; lateral lobes of the pronotum 6.7 x 5.2 wide; caudal femur 20.0 mm. Allotype deposited in the Tinkham Eremological Collection.

Paratype Males: Identical to the Holotype in every respect. Eleven males from the following locations: 5 Paratype males from the type locality; 4 from the sand dunes 33 miles north of Hanksville and just north of the San Rafael River; 1 male from Moab Dunes, 16 miles NW of Moab, 2-3 August, 1958; all collected by Ernest R. Tinkham. One male Paratype from Emery County, 21 July, 1921, Grace Olive Wiley. Range in measurements in millimeters: total length 37.0—42.2; length to apex of caudal femur 27.5—30.5; body length 27.0—30.5; pronotum 5.5—6.3 x 4.9-5.7 in breadth. Paratypes to be deposited in the following collections: Academy of Natural Sciences of Philadelphia; Brigham Young University, Los Angeles County Museum, University of Michigan and United States National Museum, and Tinkham Collection.

Paratype Females: Identical to the Allotype Female in every respect. 22 Female Paratypes from the following locations: 10 from the Type Locality; 9 from the sand dune areas 33 miles north of Hanksville; 1 from Moab Dunes all collected by Ernest R. Tinkham. 2 female Paratypes from Emery County, July 21, 1921, Grace Olive Wiley.

Range in millimeters: Total length to apices of caudal tegmina 44.5—49.5; length to apices of caudal femora 33.8—25.2; length to apex of ovipositor 34.9—37.4; pronotum 6.5—7.0 x 6.2—7.0 in breadth; lateral lobes of the pronotum 7.2—7.2 x 5.2—4.8 mm. Distribution of Paratypes as indicated above.

T. a. gracewileyae represents the optimum development of the species on the hot sand dune areas of the San Rafael Desert of southeastern Utah.

In addition to the type series there is in the Tinkham Eremological Collection considerable atypical material of *gracewileyae* originating in more distant sand dune areas. These areas are found in southwestern Utah, in the Navajo country of northern Arizona and extreme northwestern New Mexico. They lie at higher elevations within the Pinyon-Juniper Zone or the Pine Zone where cooler temperatures and colder nights prevail.

Specimens of *T. agrestis* from these dune areas are much the same size as typical *T. agrestis* from Nebraska but such morphological features as the deeper sulcation of the frontal costa and the deep and ventrally expanded lateral lobes of the pronotum, coloration and other additional features, indicate *gracewileyae* rather than *agrestis* is represented. However, due to their much smaller size they cannot be considered typical *gracewileyae* which as already stated is, with the exception of *magnifica*, the largest species of the genus.

These atypical *gracewileyae* come from the following locations: Utah: Coral Pink Dunes, Kane County, elevation 6000-6500 in the

Pine Zone, August 4-5, 1958, Ernest R. Tinkham, 8 males, 25 females, 1 female nymph. Arizona: Kayenta Dunes, 1 mile north of Kayenta, Navajo County, August 1, 1958, Ernest R. Tinkham, 15 males, 8 females. Tonalea Dunes, Conconino County, August 1, 1958, 1 male. These are the first Arizona records. New Mexico: sand areas along the San Juan River at Shiprock, San Juan County, July 23, 1948, Ernest R. Tinkham, 1 female. Small sand patch in Pine Zone, 5 miles east of Window Rock, McKinley County, July 22, 1948, Ernest R. Tinkham, 1 female.

In a 1959 publication I have reported on the self-burial habits of *T. agrestis* observed on the Coral Pink Dunes. This species and *Coniana snowi* are the only two Nearctic acridids, known to date, exhibiting self-burial habits. Self-burial habits in acridids of the Mediterranean and Ethiopian Faunal Regions are much better known and have been the subject of much study by Old World Orthopterists. Perhaps it is the cold nights that induce self-burial habits in certain arenicolous acridids. Nights on the brick-red sands of the Coral Pink Dunes, high in the Pine Zone just east of Zion National Park, are much colder than those on the Cane Spring Dunes of the San Rafael Desert and undoubtedly accounts for the absence of such self-burial traits in typical *gracewileyae*. Those interested for a full account of this interesting phenomenon are referred to the recently published article.

On the Coral Pink Dunes, I found atypical *gracewileyae* very abundant, showering out of the green patches of a legume *Psoralea stenostachys* Rydberg that were growing in the deep depressions surrounded by high dunes. In these depressions their heavy black-banded yellow wings made a colorful show. At dusk they congregated on the sands under these legume plants but later that night, by lantern light, I found them resting in the leafy tops of these foot high leguminous plants. Counts made at night revealed 6 to 10 of these hoppers per square yard in these green patches of legume. Out on the bare sand dunes very few hoppers ever spent the night. Those that did kicked holes in the sand with their caudal tibiae and rested in these depressions for protection during the cold night.

Trimerotropis agrestis barnumi n. subsp.

In 1958, I collected some small nymphs of *T. agrestis* on June 15 from low dunes 2 miles NW of Flowell, Millard County, Utah, and by feeding these emerged into imperfect adults some weeks later. As they indicated a new race, efforts were made in July, 1960, to obtain a goodly series, and such was found at the Oak City Dunes, July 26. These dunes lie about 3 miles WSW of Oak City and are traversed by Utah Highway No. 125 going west to Delta. Where scurf pea *Psoralea* carpeted the low dunes the new race was quite abundant, as many as several per sq. yd., but where the sand was bare and *Psoralea* absent so was this hopper. They had the habit of flying only a few feet, the males with rather a loud buzzing sound,

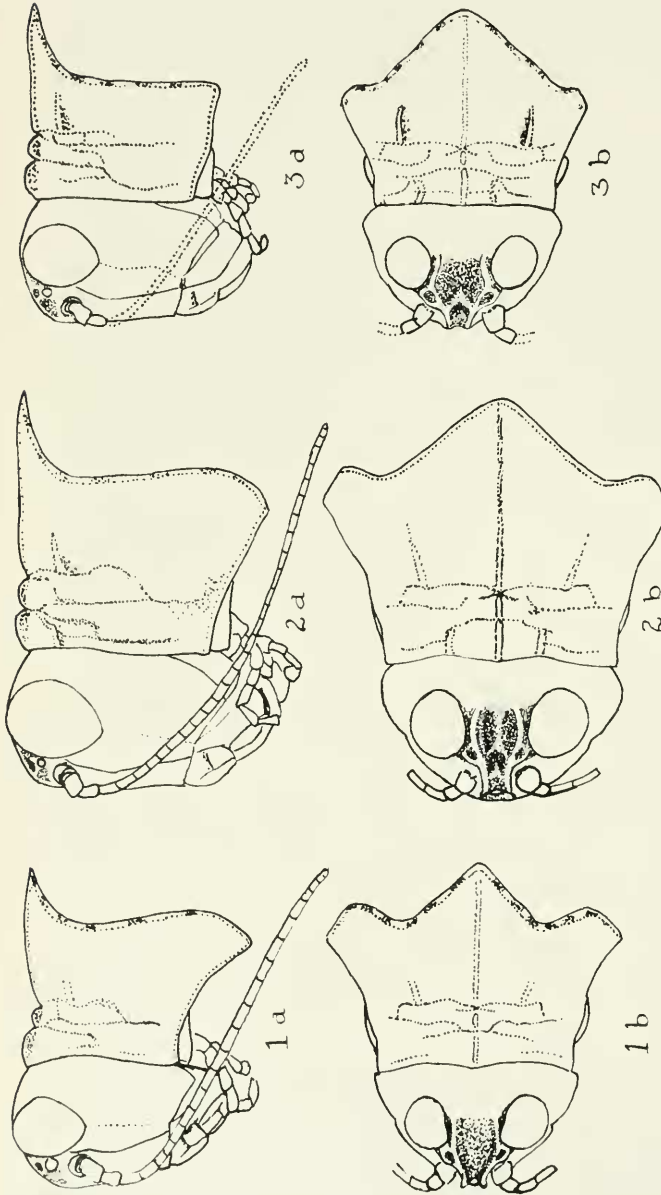
the females with a low distinct whir, on short rapid flights but as the sand was 58.0°C. at 10:15 a.m., July 26, they did not long remain on the sand but within a few minutes crawled or hopped for the nearest shade under the scurf peas. Several hours later at the Hawbush Dunes, 10 miles north of Flowell on the road to Delta, when the sand was over 60.0°C. they immediately hopped off the sand into or on top of the scurf peas. At this time they were much more wary and flew greater distances than those at the Oak City Dunes.

Description: Male: Slightly larger than the nominal race but considerably smaller than *T. a. gracewileyae* of the San Rafael Desert. Differs from *T. a. agrestis* and *T. a. gracewileyae* by the greater expansion and prolongation downwards of the posterior lateral lobe of the pronotum, the apex of which is reflexed outward and quickly discernible to the unaided eye when viewed from above (compare figures a and b of 1, 2, and 3). Additional distinguishing features are found in the fastigium, the lateral foveolae, the frontal costa, size of the eyes, the lateral profile of head and pronotum, the lateral carinae on the shoulders of the metazona and perhaps other features as well. The posterior extremity of the dorsum of the metazona is exactly right-angled and acutely rounded whereas in *agrestis* and *gracewileyae* this angle is slightly obtuse (approx. 100°) and the apex well rounded (compare b figures). However, the diacritical feature is the enormous prolongation downward of the lateral lobe of the pronotum which will distinguish *barnumi* from all other Nearctic species of *Trimerotropis*.

Description: Head conformation typical of the genus with eyes sub-globose, their vertical depth very slightly greater than the genal groove, their breadth slightly less than their depth. Fastigium of the vertex concavely sunken throughout, margined by well defined lateral carinae which are percurrent with the lateral margins of the frontal costa. The lateral carinae of the fastigium commence centrally between the compound eyes, diverging gently to the lateral foveolae of the vertex, where, at the anterior margin of the eyes, they converge rather strongly in a straight line to the point of stricture with the frontal costa just above the antennal bases where they again expand around the median ocellus to continue diverging gently to almost the clypeal margin where they evanesce. At the stricture above the median ocellus their separation is slightly less than half the breadth of the fastigium of the vertex. In lateral profile the dorsal margin of the compound eyes slightly crests the ridge of the fastigial carinae, the fastigium rounds evenly into the frontal costa. Lateral foveolae small, lateral, narrow, and not as broad and discernible as in *T. a. agrestis* or *T. a. gracewileyae*.

Pronotum broad, somewhat compressed or squattish, rather short in length with the lateral lobe margins divergent ventradly, the posterior angle especially with the huge lobes somewhat reflexed outwardly—this character being the chief diacritical feature of the new race *barnumi*. The median transverse sulcus crosses the anterior third, the metazona flat with a bare line of median carina; the pro-

zona gently raised into two rounded lobes, the anterior of which is slightly the highest and twice the length of the smaller posterior one. Metazona angular at the shoulders but with little evidence of carinae



Explanation of Plate

- 1 a. *Trimerotropis agrestis barnumi* n.subsp. Lateral view of head and pronotum of Allotype Female, Oak Dunes, Millard County, Utah.
 - 1 b. *T.a.barnumi* showing dorsal view of Allotype Female.
 - 2 a. *T. a. gracewileyae* n. subsp. Lateral view of head and pronotum of Allotype Female, Cane Springs Dunes, 19 miles north of Hanksville, Emery County, Utah.
 - 2 b. *T. a. gracewileyae* showing dorsal view of head and pronotum of Allotype Female.
 - 3a. *T. agrestis* McNeill. Lateral view of head and pronotum of female from Halsey, Nebraska.
 - 3 b. *T. agrestis* McN. Dorsal view of head and pronotum of Halsey female.
- All drawings executed to the same scale and 6.5 x natural size. Drawings reduced for reproduction about one-third.

in the anterior portions. In profile, the lateral lobes are deeper than broad, the lateral margins strongly divergent downwards, the posterior angle enormous causing the lower margin to slope strongly downwards caudally (see fig. 1 a). Tegmina projecting beyond the apices of the caudal femora by one-third their length. Caudal femora slightly heavier than typical in the genus.

Coloration: head and thorax grayish white, profusely mottled with grayish black with suffusions of yellowish on the shoulders of the metazona and the area surrounding the base of the antenna. Tegmina isabelline with the first anal vein area streaked with yellowish for its entire length. Caudal femora with outer pagina mottled with dark gray, upper sulcus mottled and with a yellowish tinge, lower sulcus white. Inner pagina uniformly dull reddish, merging to yellowish at the outer edge of the lower sulcus. Caudal tibiae orange red with a tinge of white at the outer base; tibial teeth half-tipped with black.

Wing twice as long as broad with a black band commencing near the anal angle where it is 3.0 mms wide, edging the hind margin to about midway where it curves forward as a band 6.5 mms broad to narrow slightly as it reaches the central portions of the fore margin; spur very short and blunt barely 2.0 mm. long. Apical portions beyond the band transparent with three veins and venules black, the remainder clear. Disc of wing pale yellow, its breadth about two-fifths the length of the wing.

Holotype: Male: Oak City Dunes, 5 miles WSW Oak City, Millard County, elev. 4600 ft.; July 26, 1960, Ernest R. Tinkham on sand covered with *Psoralea*. Caliper measurements in millimeters: body length 26.2; length to tip tegmen 33.8; pronotum 4.9 x 3.5 at anterior metazonal shoulders; lateral lobes 4.9 max. depth 4.1 max. breadth; tegmen 27.6; caudal femora 14.8. Type in the Tinkham Eremological Cln.

Allotype: Female: Size larger but quite closely similar to the Holotype male in most respects. Fastigium of the vertex broader; the fastigial carinae more divergent forward to the front margin of the eyes. thence more convergent forward to the stricture of the frontal costa just above the antennae. Lateral foveolae, small, their plane horizontal but set below the carinal ridge as if crowning the lateral ocelli. Head otherwise similar to the male. Pronotum, tegmina and other body features identical to the Holotype. Ovipositor developed for sand excavation, the upper valvulae with strongly recurved apices, its surface deeply excavate; lower valvulae typical. Coloration closely similar to the Holotype but with a slightly more yellowish tinge. Wing similar to that in the Holotype.

Allotype: Female: same data as the Holotype. Caliper measurements in millimeters: body length 28.8; length to tip of tegmen 37.2; tegmen 30.6; pronotum 6.8 x 4.0 at metazonal shoulders; lateral lobes 5.5 (shoulder to apex of lateral angle) x 4.2 at maximum breadth. Type in the Tinkham Cln.

Paratype Males: 25♂ from the type locality; 7♂ Hawbush

dunes, 10 miles north Flowell on road to Delta, July 26, 1960; 1 ♂, dunes 10 miles north of Lynndyl, Juab County, June 20, 1958, nymph reared to adult, all Ernest R. Tinkham. Four males, dunes 10 miles north of Lynndyl, July 30, 1957, Andrew Barnum. Range in caliper measurements in millimeters: body length 22.5—25.5; length to tip tegmina 30.0—33.9; tegmina 25.0—28.5; pronotum 4.6—4.8 x 2.9—2.9 (at anterior metazonal shoulders); lateral lobes of pronotum 4.3—5.0 (max. depth) x 3.5—4.0 (max. breadth). Paratypes to be deposited in U.S.N.M., Museum of Zoology at University of Michigan, Academy Nat. Sci. of Philadelphia, Minnesota, Brigham Young, Los Angeles Museum and California Academy of Sciences.

Paratypes identical to the Holotype male with very slight changes in coloration verging to more reddish to match the coloration of the sands.

Paratype Females: 10 ♀ from the type locality of the Allotype; 7 ♀ Hawbush Dunes, July 26, 1960, Ernest R. Tinkham. 4 ♀ dunes 10 miles north of Lynndyl, Juab County, 30 July, 1957, Andrew Barnum. Range in millimeters: body length 26.4—30.6; length to apex tegmina 34.8—39.1; tegmina 29.4—32.7; pronotum 4.8—6.0 x 3.6—4.6; lateral lobes 4.5—5.5 x 3.8—4.7 mm. Deposition as with male Paratypes.

Female paratypes identical to the Allotype in every respect with slight changes in coloration as noted in the male Paratypes.

As I found nymphs only on June 15 and 20 of 1958 at the Flowell and Lynndyl dunes and these emerged as adults a month later, this new race probably does not mature before mid-July on the dunes. I collected several nymphs on July 26, 1960, at the Oak City and Hawbush dunes indicating that molting was not quite complete at this time.

The nymph of *T. a. barnumi* has the lateral lobes of the pronotum even more strikingly enlarged than in the adult and truly is a remarkable creature.

The only other acridids found associated with *T. a. barnumi* in the *Psoralea* habitat on the Oak City dunes were *Trimerotropis p. pallidipennis* and *Melanoplus packardi*. On bare stretches of sand *Trimerotropis strenua* was rare. At night sand treaders were rare as these dunes are very dry. At the Hawbush dunes *barnumi* was associated with *Conozo a. wallula* and *Trimerotropis bilobata* with *Hesperotettix* sp. and *Melanoplus* sp. inhabiting *Chrysothamnus* spp. bushes growing on the low dunes. The nocturnal sand treaders were commoner here because the dunes were lower and damper with meadows and ponds even present in certain places.

The new Western Utah race of *T. agrestis* is named in honor of that young and promising Utah Orthopterist. Mr. Andrew Barnum, whose work on Utah Orthoptera, particularly the Oedipodinae, is commendable.

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